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WM. A. TAYLOR, Chief

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THE HANDLING AND SHIPPING OF FRESH CHERRIES AND PRUNES FROM THE WILLAMETTE VALLEY.[1]

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INTRODUCTION.

There is a large bearing acreage of prunes in the district adjacent to Salem, Oreg., as well as in the Willamette Valley generally, and during the last few years there has been planted a considerable acreage of cherries. As a general rule, the prunes are nearly all evaporated, while the cherries are usually canned or put up in barrels for maraschino purposes. Only a small percentage of the cherry crop is evaporated. The economic and crop conditions are such that during certain seasons it would be a distinct advantage to market a portion of the crop in a fresh state instead of evaporating or canning almost the entire product, as is the case at the present time. Many attempts have been made to ship both fresh prunes and cherries to eastern markets, but with indifferent success. Great difficulty has been encountered in shipping from this section for any considerable distance any of these fruits in a green state.

The problem is rendered particularly difficult and acute because of the very humid climate of this section and the frequent rains during both the cherry and prune harvesting seasons. The Willamette Val-

[1] B. B. Pratt and A. W. McKay, formerly pomologists in fruit handling and storage investigations, and G. M. Darrow and G. W. Dewey, of the Office of Horticultural and Pomological Investigations, were all actively engaged in the prosecution of these investigations.

Note.—This bulletin will be of interest to fruit growers in the Willamette Valley and similar sections.

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ley is on the west side of the Cascade Range, and the climate is considerably more humid than in most of the other fruit-producing sections on the Pacific coast. Because of this humid climate and the frequent rains during the harvesting season, both cherries and prunes may split or crack badly before or at maturity, and oftentimes they are attacked by brown-rot, so common in peaches and stone fruits in different sections of the country.

During the season of 1911 an investigation of the relationship of handling and precooling to the behavior of sweet cherries and prunes in transit to the market was commenced at Salem, Oreg. The work was undertaken in response to urgent requests from the Salem Fruit Union, a cooperative marketing organization of growers at that time handling most of the prunes grown in this district, as well as most of the cherries marketed in a fresh condition. The Department of Agriculture had the hearty cooperation of the members of this association and the growers generally. The Salem Fruit Union constructed in their warehouse at Salem a small precooling plant designed by the department. This plant was put at the disposal of the department, giving most excellent facilities for experimental work in the handling and precooling of various deciduous fruits. Because of the cooperation mentioned and the facilities offered in the way of precooling equipment, Salem was considered an ideal place for experiments in both the handling and precooling of such fruits as prunes and sweet cherries.

PURPOSE OF THE INVESTIGATIONS.

The investigations were planned with a view of ascertaining primarily the relation of two factors, handling and precooling, to the decay of these fruits in transit and on the market when shipped in a fresh or green state. The term "green" in this discussion is used to designate fruit shipped fresh, in contrast to fruit canned or evaporated. If a considerable proportion of the crop could be successfully shipped in this way during certain seasons, it would tend greatly to steady and stabilize the industry and permit its further profitable extension. The results would also indicate the important relationship of methods of handling to the decay of such fruits in transit and on the market, no matter where grown.

During the seasons of 1911 and 1913, the two seasons during which these investigations were carried on, the conditions were extremely unfavorable for green-fruit shipping, frequent rains interrupting both the sweet-cherry and prune picking during the harvesting seasons. The results obtained, however, particularly from the careful-handling experiments, are entirely consistent with the previous results of the department's fruit handling and transportation investigations. While the work in the Willamette Valley did not extend

over as many seasons as is usually considered desirable in order to warrant definite conclusions and recommendations, the marked and consistent results obtained, in spite of extremely unfavorable weather conditions, are considered of more than ordinary value and importance. The results of the experimental work with both cherries and prunes serve further to corroborate the results of similar work with oranges, lemons, apples, pears, red raspberries, peaches, and pineapples, and to emphasize the great importance of the most careful handling in preparing fruit for shipment.[1]

OUTLINE OF THE EXPERIMENTS.

Both careful-handling and precooling investigations were conducted with sweet cherries and prunes during the season of 1911. The work with prunes during the season of 1913 was confined largely to the precooling of carefully handled lots, there being no comparable commercially handled lots of fruit for purposes of comparison, as rainy weather during the harvesting season rather discouraged fresh-fruit shipments, especially as the prices prevailing for evaporated or dried fruits were eminently satisfactory. On account of the impracticability of securing a consignment of any definite number of cars to any one market, actual shipping experiments had to be omitted during both years, and all experimental series were held in an iced car at Salem.

Everything possible was done to make the conditions in the refrigerator holding car comparable with the conditions existing in fully loaded cars in transit, but even with the most careful attention to the details of icing, of placing the fruit in racks at different heights from the floor to obtain various desired temperature conditions, and of other precautionary measures, the general temperature conditions in the holding car were probably more favorable to the fruit than they would have been under actual transit conditions. The nonprecooled fruit cooled more quickly and the ripening processes and the development of mold fungi proceeded more slowly in the holding car than would have been the case if shipped in a fully loaded and iced refrigerator car. In view of these facts, the results obtained may be considered even more impressive, as it is reasonable to expect that differences between carefully handled and ordinarily handled fruit would be even greater under actual shipping conditions than those found in a stationary, partially filled, iced refrigerator car. The differences between precooled and nonprecooled

[1] Powell, G. H., and others. The decay of oranges while in transit from California. U. S. Dept. Agr., Bur. Plant Indus. Bul. 123, 79 p., 26 fig., 9 pl. (2 col.), 1908.

Stubenrauch, A. V., Ramsey, H. J., Tenny, L. S., and others. Factors governing the successful shipment of oranges from Florida. U. S. Dept. Agr. Bul. 63, 50 p., 26 fig., 15 pl., 1914.

Ramsey, H. J. Factors governing the successful shipment of red raspberries from the Puyallup Valley. U. S. Dept. Agr. Bul. 274, 37 p., 26 fig., 1915.

fruit certainly would be much greater under transit conditions than under the holding conditions described.

The cherries were held in the iced car for lengths of time approximating transit periods of 5, 10, and 15 days. Inspections were made at withdrawal, and again 2 and 4 days after withdrawal. The prunes were inspected after holding periods of 10, 15, and 20 days in a refrigerator car, and again 2, 4, and 6 days after withdrawal from the car.

CAUSES OF DECAY IN TRANSIT.

The losses caused by the decay of cherries and prunes in transit are due primarily to fungi gaining entrance through mechanical abrasions in the skin or other injuries and to brown-rot (*Sclerotinia fructigena*). In general, these may be divided into two groups: (1) The fungi which have not the power to penetrate the sound, unbroken skin of fruits, but depend entirely upon injuries or mechanical abrasions for entrance, and (2) the fungi which can attack and cause the decay of sound fruit, either on or off the tree. An instance of the latter is the brown-rot, which, during certain seasons, is very serious on stone fruits. The investigations during the seasons of 1911 and 1913 show that this fungus is the cause of serious losses in transit, both in cherries and prunes, and the prevention of such losses must necessarily be dependent upon proper and effective orchard sanitation and spraying practices.[1]

The most common fungi gaining entrance through injuries and mechanical abrasions and causing serious losses in transit are the common gray mold (Botrytis) and blue mold (Penicillium). These two fungi are responsible for most of the losses, aside from those occasioned by brown-rot. They gain entrance either through mechanical abrasions or injuries made in picking, hauling, and packing, or through cracks and splitting in both cherries and prunes by reason of rainy weather just prior to or at harvesting time. These fungi are dependent upon injuries or breakages of the skin for entrance; hence, the remedy obviously lies in the handling of the fruit in such a way as to prevent bruising and injury and in the careful grading out of all cracked or split fruit at the time of packing.

CHERRY INVESTIGATIONS.

DESCRIPTION OF COMMERCIAL HANDLING METHODS.

As previously stated, the greater part of the cherry crop in this section is either canned, put up in barrels for maraschino purposes, or evaporated. Under ordinary conditions of handling, either for the

[1] Jackson, H. S. Diseases of drupaceous fruits.—Brown-rot of stone fruits. *In* Oreg. Agr. Exp. Sta., Bien. Crop Pest and Hort. Rpt., 1911–12, p. 248–250, fig. 3, 1913.

Bailey, F. D. Experimental spraying of prunes for control of brown-rot. *In* Oreg. Agr. Exp. Sta., 2d Bien. Crop Pest and Hort. Rpt., 1913–14, p. 241–244, 1915.

purposes enumerated or for fresh-fruit shipment, the cherries are picked into pails, or buckets, of various sizes and types. Five-pound pails and 10-pound buckets are the most common, some of the buckets now in use having canvas bottoms as an added protection to the fruit, both in picking into the pail and in emptying into the field box. The pickers are paid by the pound, and as most of the fruit goes to the canneries or is intended for maraschino firms, not any too much care is exercised in picking. The cherries are grasped by the pedicel, and in the course of picking considerable bruising results from the holding of several in the hand before placing them in the pail or box. The fruit is emptied from the picking pail into boxes holding approximately 50 pounds and in these is hauled to the cannery or packing house.

Fruit for shipment is ordinarily packed in the standard 10-pound cherry box with two compartments, each about 10 inches square and 2½ inches deep. The box is first faced with two layers of cherries diagrammatically arranged according to the size of the fruit, the rest being simply filled in. In putting in the facing layers, the fruit must be packed very firmly and tightly. The facing operation often results in breaking the internal structure of the cherry and in much bruising, which later develops into serious decay. Up to the present time this territory has seldom had enough fresh cherries in good condition to warrant car-lot shipments, and for that reason most of the fruit is sent out in small lots to the near-by cities, to points in California, and to markets occasionally as far east as Denver. The pony refrigerator is not used to any extent, and nearly all the fruit is shipped without refrigeration.

CAREFUL-HANDLING EXPERIMENTS.

The careful-handling experiments with cherries were carried on during the season of 1911. Table I and figure 1 give the average results of these experiments for that season. A study of these data emphasizes very strongly the relationship of handling to the condition of cherries in transit and on the market.

The decay figures, as given in Table I, are a total of all decay, exclusive of brown-rot, although it was quite impracticable in all cases to separate with absolute accuracy this trouble from other forms of decay. At the end of five days in the iced car, the carefully handled fruit showed only 0.5 per cent of decay, while the comparable commercially handled fruit showed 2.8 per cent of decay, practically six times the decay found in the comparable carefully handled lots. The results are equally striking at the end of transit periods of 10 and 15 days, the carefully handled fruit having 1.5 per cent of decay at the end of 10 days and 4.3 per cent of decay at the end of 15 days,

respectively, as against 12.3 per cent of decay and 16 per cent of decay for the same periods in the commercially handled fruit. At the end of a 10-day transit period, which is approximately equal in time to shipment to Chicago, the commercially handled fruit showed over eight times as much decay as developed in the same fruit when carefully handled.

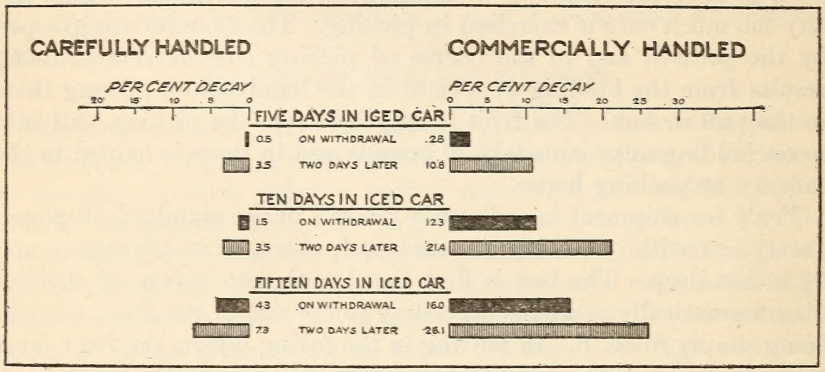
CAREFULLY HANDLED
COMMERCIALLY HANDLED
PER CENT DECAY
PER CENT DECAY
20 15 10 5 0
0 5 10 15 20 25 30
FIVE DAYS IN ICED CAR
0.5 ON WITHDRAWAL .28
3.5 TWO DAYS LATER 10.8
TEN DAYS IN ICED CAR
1.5 ON WITHDRAWAL 12.3
3.5 TWO DAYS LATER 21.4
FIFTEEN DAYS IN ICED CAR
4.3 ON WITHDRAWAL 16.0
7.3 TWO DAYS LATER 26.1

FIG. 1.—Diagram illustrating the percentages of decay in carefully and commercially handled cherries, Salem, Oreg., 1911.

TABLE I.—*Decay in carefully and commercially handled cherries, Willamette Valley, season of 1911.*

Time in iced car.	Time and manner of handling and extent of decay (per cent).			
	On withdrawal.		Two days after withdrawal.	
	Careful.	Commercial.	Careful.	Commercial.
5 days	0.5	2.8	3.5	10.8
10 days	1.5	12.3	3.5	21.4
15 days	4.3	16.0	7.3	26.1

MARKET HOLDING TESTS.

It is not only essential that the fruit be delivered on the market in sound condition, but it is also of the greatest importance that it remain in good, sound condition for a reasonable period, for distribution to the consumers. Fruit that does not keep well after arrival or which shows considerable spoilage while in the wholesalers' or retailers' hands soon gets a reputation for poor keeping quality and is seriously discounted, even though it arrives in practically sound condition.

The differences, as indicated in Table I, between commercially and carefully handled fruit two days after withdrawal are, if anything, more striking than the results on arrival. The inspection of the care-

fully handled lots of fruit two days after withdrawal from the car and after holding under ordinary market conditions for 5, 10, and 15 day transit periods showed, respectively, 3.5, 3.5, and 7.3 per cent of decay. The comparable commercially handled fruit two days after withdrawal showed 10.8, 21.4, and 26.1 per cent of decay, respectively, after corresponding transit periods. The commercially handled fruit in the car for 10 days and held for two days under open-market conditions developed more than six times the decay found in the same fruit when carefully handled.

RELATION OF HANDLING AND CULTURAL PRACTICES TO DECAY.

The striking results obtained in the careful-handling experiments indicate that if proper care is exercised in handling, picking, hauling, and packing, the shipment of cherries in a fresh state as far as Chicago would be entirely practicable. With the present commercial-handling methods, however, the long-distance shipment of fresh sweet cherries is not likely to prove uniformly profitable or successful, not only on account of the decay occurring in transit but because of the great amount of decay that develops during only a 2-day holding period on the market. Even though cherries can be delivered in fairly sound condition through careful attention to the details of handling, precooling, and refrigeration in transit, the problem of the successful shipment of cherries in a fresh state from the Willamette Valley and sections with similar climatic conditions involves more than harvesting and shipping practices alone.

The humid climate and frequent rains during the harvesting season render fruits like cherries and prunes extremely subject to serious attack by brown-rot. Rains during the harvesting season cause considerable splitting, especially with certain varieties of cherries, and while the badly cracked cherries are usually all graded out, it is impossible to grade out all the fruit affected with brown-rot. This type of decay in a package spreads very rapidly to adjoining fruits by contact, and in this respect is unlike the common molds, such as Penicillium and Botrytis, which depend largely on injuries for entrance. During some seasons brown-rot is not very serious. Nevertheless, if the growers of cherries make a business of fresh-fruit shipping, success will depend not only upon the exercise of proper care in handling but also upon correct cultural and spraying practices.

WHAT CONSTITUTES CAREFUL HANDLING.

The question of what constitutes the careful handling of cherries may, perhaps, be partially answered by describing the methods used in picking and packing the experimental lots. The cherries, as is customary, were picked by grasping the stems and exercising care not

to hold too many in the hand or to crush or bruise them in any way while picking and before placing in the pail or bucket. A 5-pound pail was used in the experimental work, the bottom being lined with paper. The cherries were all placed in the pail carefully and not dropped in or thrown in, as is often the commercial practice. In emptying into the orchard box great care was also exercised to prevent bruising and injury. The pail was first lowered to near the bottom of the box, the fruit in emptying being held back by the hand so as to allow it to roll gently into the box. The "lugs," or orchard boxes, were lined with paper, and not more than 25 or at the most 30 pounds of fruit were ever placed in any one box. The boxes were set in the shade until loaded on spring wagons for hauling to the packing house. In hauling to the packing house the fruit was protected by canvas or dusters from the dust and sun.

The carefully handled lots were picked and packed by representatives of the Bureau of Plant Industry, the ordinary 10-pound box being used for packing. The fruit was packed directly from the lug box, and all stemless, cracked, bruised, or injured fruit was graded out, special effort being made to pack the facing layers firmly and the rest of the box without bruising any of the fruit or breaking down its internal structure. The results of this extra care and the relation of handling methods are clearly brought out in the table and charts previously referred to. These favorable results were obtained by using practically all the ordinary equipment common in commercial practice. No doubt better picking receptacles than the paper-lined 5-pound pails, for instance, can be found. However, given any picking receptacle or pail, the care exercised in picking the fruit, in placing it in the pail, and in transferring it to the orchard box determines the amount of injury in picking and the resultant decay. The amount of injury done in picking and hauling is strikingly shown in the inspection of several lots of commercially handled fruit in the packing house before packing. In some instances 75 per cent of all the fruit examined showed evidences of serious bruising.

While these investigations indicate that cherries can be successfully shipped in the 10-pound box if sufficient care is exercised in all the operations of handling, they also prove that cherries under certain humid climatic conditions are more susceptible to injury in handling than in the more arid sections. Various growers in the Willamette Valley and in other humid sections of the Pacific Northwest have made trial shipments of cherries in berry crates, with uniformly good results. Much of the decay in transit results directly from bruises and injuries incurred in packing and facing the fruit in these 10 and 20 pound boxes. Nearly all of this bruising can be eliminated and the cost of packing very materially reduced where

berry crates or similar types of carton packages are used. A more extended trial of such packages for the shipment of cherries from sections like the Willamette Valley would seem to be desirable. The 10-pound cherry box when well packed is a very attractive package and is intimately associated with western cherries in the minds of the eastern and middle-western fruit trade. While the appearance of package and product counts for a great deal on the market, soundness is of first consideration. Even though cherries in berry crates or similar packages may not command the price that they would in the 10-pound box, it is a question whether this would not be offset by the decreased cost of packing and the better condition of the fruit. These factors can hardly be satisfactorily determined without commercial tests.

PRECOOLING EXPERIMENTS.

The precooling plant constructed by the Salem Fruit Union was utilized for the precooling experiments. In these experiments both carefully and commercially handled fruit was used in each series,

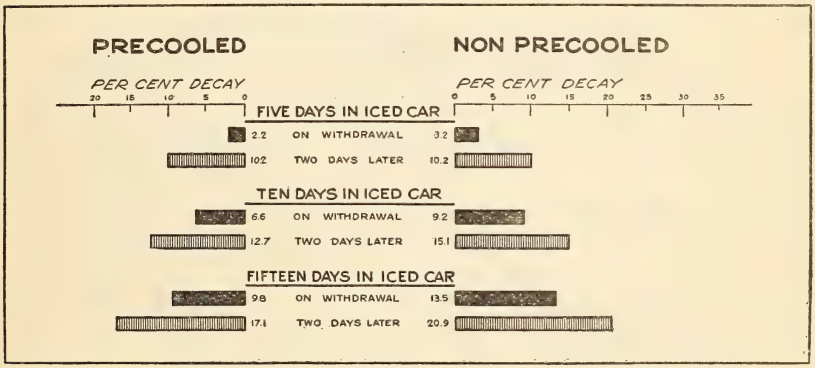
PRECOOLED
NON PRECOOLED
PER CENT DECAY
PER CENT DECAY
20 15 10 5 0
0 5 10 15 20 25 30 35
FIVE DAYS IN ICED CAR
2.2 ON WITHDRAWAL 3.2
10.2 TWO DAYS LATER 10.2
TEN DAYS IN ICED CAR
6.6 ON WITHDRAWAL 9.2
12.7 TWO DAYS LATER 15.1
FIFTEEN DAYS IN ICED CAR
9.8 ON WITHDRAWAL 13.5
17.1 TWO DAYS LATER 20.9

FIG. 2.—Diagram illustrating the percentages of decay in precooled and nonprecooled cherries commercially handled, Salem, Oreg., 1911.

one half of each lot being precooled and the other half placed in the refrigerator car without precooling. The data given in Table II, which are illustrated graphically in figure 2, show the relation of precooling to decay and market condition, wherein only the results of the commercially handled fruit are given, the small amount of decay in the carefully handled fruit being practically the same in both the precooled and nonprecooled lots.

While there are consistent differences in favor of the precooled fruit, these are not nearly so striking as the differences between the carefully and commercially handled lots, and although they bring out to some extent the value of precooling, they emphasize most strongly the importance of careful handling. The fruit in the precooling experiments was usually cooled to a temperature of 40° F.

or lower. The transfer to the iced car was made without exposing the cooled fruit to contact with the warmer air outside.

TABLE II.—*Decay in precooled and nonprecooled cherries, commercially handled, Willamette Valley, season of 1911.*

Time in iced car.	Time and treatment and extent of decay (per cent).			
	On withdrawal.		Two days after withdrawal.	
	Precooled.	Nonprecooled.	Precooled.	Nonprecooled.
5 days	2.2	3.2	10.2	10.2
10 days	6.6	9.2	12.7	15.1
15 days	9.8	13.5	17.1	20.9

The decay on withdrawal at the end of a 10-day transit period is fairly representative of the general results of the precooling tests. The precooled, commercially handled fruit at the end of 10 days showed 6.6 per cent of decay, while the nonprecooled fruit showed 9.2 per cent of decay, and after holding on the market for two days the precooled fruit developed 12.7 per cent of decay and the nonprecooled 15.1 per cent of decay. A comparison of the differences between the precooled and nonprecooled lots in Table II with the differences between the carefully and commercially handled fruit in Table I will serve to emphasize strongly the fundamental importance of careful handling. In interpreting the precooling results, however, one should bear in mind the fact that the nonprecooled lots were placed in a partially filled, well-iced refrigerator car and that these crates cooled more quickly than they would in a full carload in transit. Greater differences in decay and condition between precooled and nonprecooled fruit would naturally be expected under actual shipping conditions. One difference not brought out in the tables or charts is that of appearance, the precooled fruit being uniformly and consistently much brighter and fresher than the nonprecooled.

EFFECT OF DELAY IN LOADING AND COOLING.

Table III and figure 3 illustrate very strikingly the importance of handling the fruit from the tree to the refrigerator car or of delivering it to the carrier or transportation company with the least delay possible.

Table III gives the decay in comparable lots of fruit, one half of which had been picked, packed, and shipped immediately, the other half being delayed two days before placing in the refrigerator car. At the end of a 5-day transit period the immediate lots showed 3.2

per cent of decay, as compared with 5.2 per cent in the same fruit delayed two days before loading. The results in the lots held for 10 days are equally striking, there being 13.5 per cent of decay in the immediate and 25.4 per cent in the delayed shipments on withdrawal from the car, with 19.7 per cent in the immediate and 40.2 per cent in the delayed shipments after a market holding period of 2 days. On arrival, the delayed fruit invariably showed about twice the decay found in the fruit immediately packed and loaded.

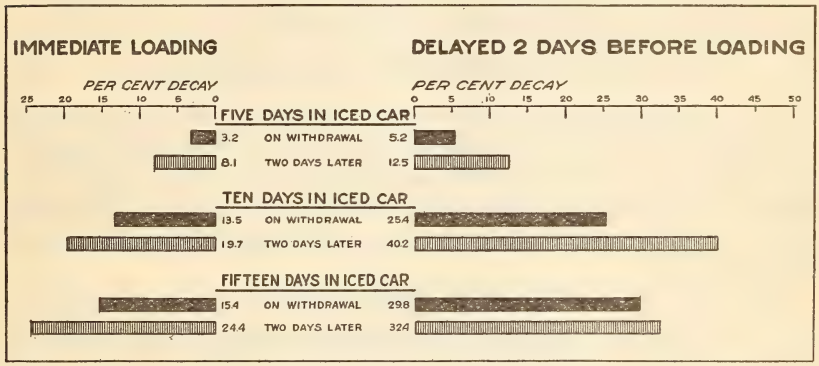
IMMEDIATE LOADING
DELAYED 2 DAYS BEFORE LOADING
PER CENT DECAY
25 20 15 10 5 0
PER CENT DECAY
0 5 10 15 20 25 30 35 40 45 50
FIVE DAYS IN ICED CAR
3.2 ON WITHDRAWAL 5.2
8.1 TWO DAYS LATER 12.5
TEN DAYS IN ICED CAR
13.5 ON WITHDRAWAL 25.4
19.7 TWO DAYS LATER 40.2
FIFTEEN DAYS IN ICED CAR
15.4 ON WITHDRAWAL 29.8
24.4 TWO DAYS LATER 32.4

FIG. 3.—Diagram illustrating the percentages of decay in commercially handled nonprecooled cherries loaded immediately and those delayed two days in the warehouse before loading, Salem, Oreg., 1911.

TABLE III.—*Decay in commercially handled nonprecooled cherries immediately loaded and in those delayed two days in the warehouse before loading, Willamette Valley, season of 1911.*[1]

Time in iced car.	Time factors and extent of decay (per cent).			
	On withdrawal.		Two days after withdrawal.	
	Immediate.	Delayed.	Immediate.	Delayed.
5 days	3.2	5.2	8.1	12.5
10 days	13.5	25.4	19.7	40.2
15 days	15.4	29.8	24.4	32.4

[1] Slight inconsistencies and apparent discrepancies occur in this table and in some others. These, however, are easily accounted for when it is taken into consideration that it was impossible to use the same lots of fruit for more than one inspection. While the aggregate of fruit used in these inspections was large, the quantity of fruit in each experiment was necessarily limited, especially the fruit used for each inspection. The rather high development of decay in some portion of a crate, either on account of accidental injuries in handling or of decay resulting from brown-rot, is primarily responsible for most of these apparent discrepancies.

The results shown in this table serve to emphasize the desirability and the necessity of getting the fruit as quickly as possible into cooler temperatures or into the refrigerator car, or, where it is shipped without refrigeration, of forwarding it to the carrier or transportation company with the least possible delay. Holding the fruit for

any considerable time either in the field or warehouse before shipping only gives added opportunity for decay to start in bruises and injuries, while the ripening processes also proceed more rapidly under these high temperatures and result in quicker decay and deterioration. Leaving the fruit in the field for several hours, especially during hot weather, will seriously affect the shipping quality of such tender and perishable fruits as cherries. In the handling of cherries for shipment it is essential that the fruit be hauled in promptly after picking, that it be packed as soon as received at the packing house, and immediately cooled, loaded, and shipped.

SUMMARY OF THE CHERRY INVESTIGATIONS.

When the large acreage of recently planted sweet cherries in the Willamette Valley comes into bearing, the production will be greatly increased. If, therefore, cherries can be successfully shipped and disposed of in a fresh state, there would be provided a wider and possibly a more profitable outlet for a considerable proportion of the cherry crop.

The shipment of cherries in a fresh state for long distances has been more or less unsuccessful, owing to the development of a large amount of decay and deterioration in transit and on the market. This decay is due to fungi which gain entrance to and attack the fruit through mechanical abrasions made in handling, to splitting due to rainy weather at harvesting time, or to brown-rot, which infects the fruit in the orchard.

The results of these investigations demonstrate conclusively that the losses due to mold fungi gaining entrance through mechanical abrasions and injuries can be largely prevented by the exercise of proper care in picking, hauling, and packing, and in the careful grading out of all injured, stemless, and cracked fruit.

Precaution should be taken not to bruise the fruit in the hand when picking, when transferring it to the picking pail or bucket, or when emptying it from the picking receptacle into the field box.

During the time the fruit is held in the orchard after picking, it should be kept in the shade. The wagons for hauling should be provided with good springs and the load covered with canvas, in order to protect the fruit from the sun and dirt.

At the time of packing, the fruit should be carefully graded, so as to eliminate all stemless and cracked or split fruit. All cracked and stemless fruits included in the packing boxes are almost certain to decay, either from mold fungi or brown-rot.

If the fruit is packed in the ordinary 10-pound boxes, the greatest care must be exercised in putting in facing layers to prevent the bruising, injury, or breaking down of the internal structure of the fruit.

It is evident that cherries grown in humid sections subject to considerable rainy weather at harvest time are more susceptible to injury than similar varieties grown in the more arid sections, and they therefore require all the more careful handling. In view of this fact it would seem advisable where practicable to make more extended trials of shipping in berry crates, in this way obviating the necessity of tight packing.

Whether the cherries are shipped in carload lots under refrigeration or in smaller lots by express, immediate loading is essential.

Precooling or the prompt cooling of cherries before shipment is of material assistance in minimizing decay in transit. Precooling, however, is hardly justified unless the fruit is carefully and properly handled, and it should never be depended on to overcome the bad effects of rough or careless handling. It is essential that the fruit be cooled as quickly as possible after picking, that the precooling be thoroughly done, and that the fruit be transferred to the refrigerator car without exposure to the warmer outside temperatures.

PRUNE INVESTIGATIONS.

EXTENT AND STATUS OF THE INDUSTRY.

Prune growing is the leading horticultural industry of those portions of Polk and Marion Counties adjacent to Salem, as well as of several other counties in the Willamette Valley, Oreg. The Italian prune is the variety most widely planted and was used exclusively in these handling and precooling investigations. As almost the entire product of the section in the vicinity of Salem and in the Willamette Valley generally is evaporated, all cultural and handling operations have been developed with this end in view.

While the main dependence must be placed on marketing the product in an evaporated state, during most seasons it would be greatly to the growers' advantage if a portion of the fresh crop could be profitably shipped. The practicability of and success with fresh-prune shipments from this and other sections depend primarily on whether the product can be delivered in sound and good merchantable condition. During the seasons of 1910 and 1911 several carloads of fresh prunes were shipped to Chicago and other eastern markets under refrigeration, but with rather unsatisfactory results, due mainly to the fact that most of the shipments arrived in a badly decayed condition. Further shipments were planned for the season of 1913, but unfavorable weather conditions immediately preceding the harvesting season, along with attractive prices offered for the dried product, caused the growers to abandon all fresh-fruit shipping plans.

COMMERCIAL HANDLING METHODS.

The methods of harvesting prunes for fresh-fruit shipment are necessarily very different from those employed where the product is to be evaporated. In the latter case the prunes are allowed to fall on the ground or the trees are shaken periodically by pickers who go through the orchard with poles, especially for this purpose. As a rule, a great many pickings are made during the season. The product is afterwards picked up from the ground and hauled to the evaporators for grading and processing. The operations for harvesting prunes for shipment in a fresh state are very similar to those described for cherries. In picking, the prunes are grasped by the pedicel and placed in buckets or pails of various makes and sizes. From these they are poured into lug boxes, usually slatted and holding from 30 to 35 pounds. Sometimes the packing is done at the orchard or on the farm, but more often the prunes are hauled to a central packing house at the nearest shipping point. In the packing house the prunes are poured out on a sorting and packing table, the packers doing both the grading and packing. The package used is a 4-basket crate holding approximately 25 pounds of fruit. The sizes are designated as 4 by 5, 5 by 5, 5 by 6, and 6 by 6, the majority usually running about 5 by 5 and 5 by 6, and are based on the number of prunes in a row each way in the basket. One thousand crates constitute the usual standard carload of prunes, although the load may vary somewhat one way or the other.[1]

PURPOSE AND OUTLINE OF INVESTIGATIONS.

As previously indicated, fresh-prune shipments have not yielded uniformly satisfactory returns, largely on account of the poor condition in which the prunes arrived on the market. These investigations, therefore, were inaugurated with a view to determining whether prunes grown in the Willamette Valley and in sections having similar climatic conditions can be handled with sufficient care to deliver them on the market in good, sound condition. During the season of 1911 quite a number of commercial car-lot shipments of fresh prunes were made, and the investigations that season were planned primarily to determine the relationship of handling methods, of delayed cooling and shipping, and of quick cooling or precooling to the decay and deterioration of fresh prunes in transit and on the market.

It was impracticable to make any experimental shipments to eastern markets, on account of the impossibility of securing a sufficient number of cars for one market, and the experimental lots were

[1] Lewis, C. I., Brown, F. R., and Bradford, F. C. A prune survey of Oregon. *In* Oreg. Agr. Exp. Sta., Bien. Crop Pest and Hort. Rpt., 1911–12, p. 8–30, 8 fig., 1913.

therefore held in an iced car at Salem under conditions approximating transit conditions as nearly as possible. During the season of 1913, although arrangements had been made for several car-lot shipments of fresh prunes to one market, the weather and other conditions were such as to make necessary the abandonment of these arrangements. During that season, therefore, no comparison of carefully and commercially handled fruit was possible, and the experimental work had to be confined largely to precooling tests with carefully handled fruit, maturity tests, and a comparison of fruit from different sections and soils. While the weather conditions during the two seasons mentioned were not the most favorable for fresh-fruit shipments, they were such as occur quite frequently during a series of years, and if prunes can not be shipped more or less successfully during such seasons entire dependence must be placed on the evaporated or dried products, and everything should be done with a view to growing fruit especially for this purpose and to curing a product of the very highest market quality.

RELATION OF HANDLING TO DECAY IN TRANSIT.

During the season of 1911 a number of experimental tests were made of carefully and commercially handled fruit. The carefully handled lots were picked and packed by representatives of the Bureau of Plant Industry, the fruit being secured from the same orchards and at the same time as that handled commercially. The lots are comparable in every way except in the care exercised in the picking, hauling, and packing.

TABLE IV.—*Decay in carefully and commercially handled prunes, Willamette Valley, season of 1911.*

Time in iced car.	Time and manner of handling and extent of decay (per cent).			
	On withdrawal.		Six days after withdrawal.	
	Careful.	Commercial.	Careful.	Commercial.
10 days	0.7	3.5	2.1	8.7
15 days	.4	7.1	3.7	16.6
20 days	2.7	6.8	6.9	23.3

The data presented in Table IV, which are illustrated graphically in figure 4, show the differences in decay between the carefully handled and commercially handled fruit. These lots were held in an iced car for 10, 15, and 20 days, and were inspected on withdrawal and again 2, 4, and 6 days afterwards, only the results of the in-

spections on withdrawal and 6 days after withdrawal being shown. After 10 days in the iced car the carefully handled fruit had developed only 0.7 per cent of decay, as against 3.5 per cent for that commercially handled. Six days after withdrawal, the carefully handled fruit had developed 2.1 per cent of decay, as against 8.7 per cent for that commercially handled. After 15 days in the iced car the carefully handled fruit showed 0.4 per cent of decay and the commercially handled fruit 7.1 per cent of decay. Six days after withdrawal, this series had developed 3.7 per cent of decay in the carefully handled fruit, as against 16.6 per cent in the fruit handled in the ordinary commercial manner.

The commercially handled fruit had developed during a transit period of 10 days almost five times as much decay as the fruit handled

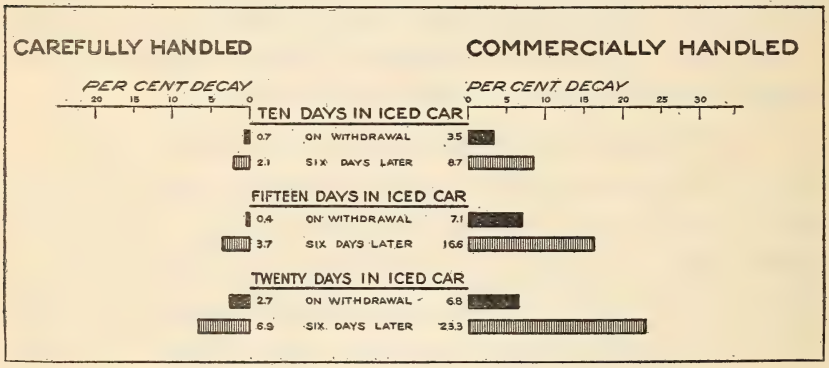
CAREFULLY HANDLED
COMMERCIALLY HANDLED
PER CENT DECAY
20 15 10 5 0
PER CENT DECAY
0 5 10 15 20 25 30
TEN DAYS IN ICED CAR
0.7 ON WITHDRAWAL 3.5
2.1 SIX DAYS LATER 8.7
FIFTEEN DAYS IN ICED CAR
0.4 ON WITHDRAWAL 7.1
3.7 SIX DAYS LATER 16.6
TWENTY DAYS IN ICED CAR
2.7 ON WITHDRAWAL 6.8
6.9 SIX DAYS LATER 23.3

FIG. 4.—Diagram illustrating the percentages of decay in carefully and commercially handled prunes, Salem, Oreg., 1911.

carefully, and after holding for 6 days on the market the commercially handled fruit still showed four times as much decay as that carefully handled. The same relative differences hold true for the 15 and 20 day periods.

These figures illustrate strikingly the important relation of handling to the decay of prunes in transit and clearly bring out the need of great improvement in handling methods before prunes can be successfully and profitably shipped from this section in a green or fresh condition. While the decay developed in the commercially handled fruit on arrival is not proportionately large, it is sufficient to affect seriously the market value of the fruit, especially in view of the rather rapid development of decay under market holding conditions. It must also be borne in mind that all of these lots were held in an iced refrigerator car under very favorable conditions, the fruit cooling very much faster than it would in a full carload and generally being held under more favorable temperatures and conditions than would be the case under ordinary transit conditions.

IMPORTANCE OF CAREFUL HANDLING AND GRADING.

An average of all the tests made during the season of 1911 indicates the urgent necessity of improvement in field and packing-house handling. Every precaution should be exercised in picking, hauling, packing, and all harvesting operations to avoid bruising or mechanical injury of any kind. In picking, the fruit should be grasped by the stem and placed by hand in a bucket or picking receptacle and should be handled in such a way as to disturb the bloom as little as possible. What has been said regarding cherries will hold equally true for prunes. Every precaution should be taken to transfer the fruit from the bucket to the lug box without allowing the fruit to drop or roll violently any distance or to rub off any more bloom than is consistent with the handling that has to be given it. Oftentimes it is the practice in the Willamette Valley to pick only the lower branches of the trees, leaving the fruit in the upper branches for drying or evaporation. In such cases it is sometimes possible to pick, at least for a portion of the time, directly into the lug box. Even if this extra care takes a little more time it is entirely practicable, and in minimizing the injury and consequent decay the slight added cost of handling is more than compensated for.

The fruit should be kept in the shade while in the orchard after picking and should be hauled to the packing house on wagons equipped with good springs. The load should also be covered with canvas or some other covering to protect it from the sun and dust. In packing, much bruising and injury can be avoided by sorting and packing directly from the lug box instead of pouring the fruit out in bins or on tables, as is oftentimes the practice. The preservation of the bloom is a very important factor in the marketing of fresh prunes. When the prunes are poured into bins or on tables, much of the bloom is rubbed off that could be preserved if the fruit were packed and sorted directly from the lug box.

It is certain that if fresh-prune shipping is to become a profitable and established phase of the marketing of this crop in the Willamette Valley, much greater care must be devoted to the handling and grading of the fruit. Not only should care be exercised to avoid mechanical injuries of every kind, but closer grading is absolutely necessary, in order that the fruit may at least leave the packing house in good, sound condition. Usually insufficient care is exercised in grading and in sorting out injured, soft, and cull fruit. This failure to grade and cull closely is partially responsible for the fact that occasionally the fruit shows some decay and deterioration prior to shipment. Brown-rot is also a considerable factor, and the decay data for both seasons include that caused by brown-rot, as it was quite impossible to separate this from other forms at all times.

The relation, however, of this form of decay to transportation conditions and the practicability of fresh-fruit shipping is well illustrated in the data giving the results of the work in 1913.

EFFECT OF DELAYED SHIPMENT ON KEEPING QUALITY.

During the season of 1911 half of all the experimental lots of prunes were held for two days in the warehouse before being placed in the precooling room or in the refrigerator car, in order to determine the effect of delayed cooling and shipping. While it is generally recognized that delay in the cooling or shipping of any perishable fruit product is inadvisable from the standpoint of decay and condition, in certain localities a delay of two or three days is of frequent occurrence. This is especially true where two to four days are

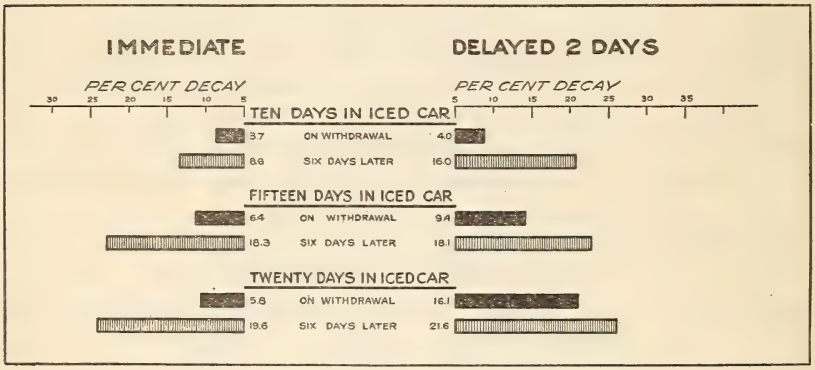
IMMEDIATE
DELAYED 2 DAYS
PER CENT DECAY
PER CENT DECAY
30 25 20 15 10 5
5 10 15 20 25 30 35
TEN DAYS IN ICED CAR
3.7 ON WITHDRAWAL 4.0
8.6 SIX DAYS LATER 16.0
FIFTEEN DAYS IN ICED CAR
6.4 ON WITHDRAWAL 9.4
18.3 SIX DAYS LATER 18.1
TWENTY DAYS IN ICED CAR
5.8 ON WITHDRAWAL 16.1
19.6 SIX DAYS LATER 21.6

FIG. 5.—Diagram illustrating the percentages of decay in commercially handled nonprecooled prunes immediately loaded and those delayed two days in the warehouse before loading, Salem, Oreg., 1911.

required to assemble a full carload, the fruit meantime being held in sheds or packing houses.

Table V and figure 5 give a comparison of decay in commercially handled fruit loaded immediately and delayed two days in the packing house before loading. After a transit period of 10 days the fruit immediately loaded had developed 3.7 per cent of decay and the delayed fruit 4 per cent. After a 15-day holding period the immediate and delayed lots had developed 6.4 per cent and 9.4 per cent of decay, respectively, and the immediately loaded fruit in transit 10 days and held 6 days under ordinary market conditions showed 8.6 per cent of decay, as against 16 per cent for the fruit delayed two days prior to shipment. While these differences are not as striking, or perhaps as consistent, as those found between carefully and commercially handled fruit, they nevertheless indicate the necessity of prompt shipment after picking and packing. The seriousness of delay before loading and shipping will also depend largely upon the temperature conditions at harvesting time. If the temperatures are abnormally high, a delay of a few hours in the packing

house may be as serious as two or more days during periods of rather low temperatures.

TABLE V.—*Decay in commercially handled nonprecooled prunes immediately loaded and in those delayed two days before loading, Willamette Valley, season of 1911.*

Time in iced car.	Time factors and extent of decay (per cent).			
	On withdrawal.		Six days after withdrawal.	
	Immediate.	Delayed.	Immediate.	Delayed.
10 days	3.7	4.0	8.6	16.0
15 days	6.4	9.4	18.3	18.1
20 days	5.8	16.1	19.6	21.6

Table VI and figure 6 present a comparison of immediate and delayed shipments of carefully handled prunes during the seasons of 1911 and 1913. The results in the carefully handled lots during

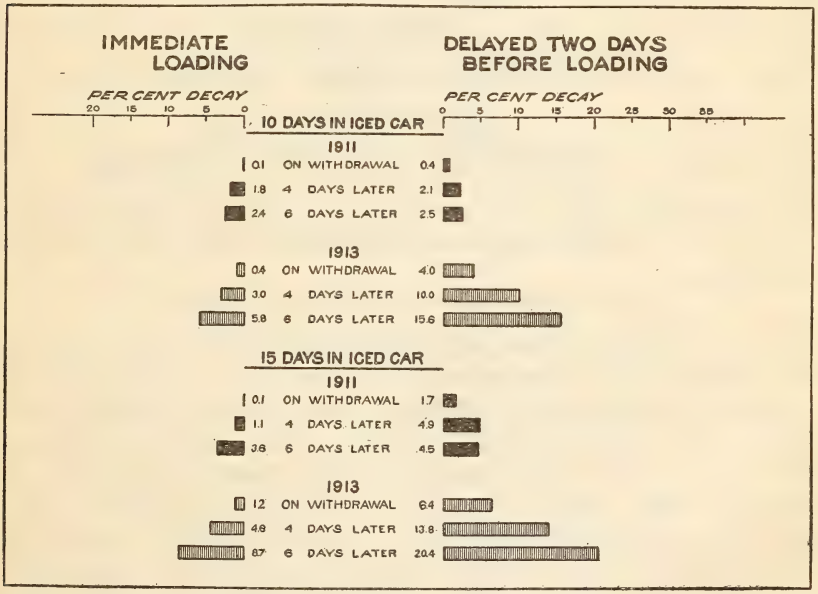
IMMEDIATE LOADING
DELAYED TWO DAYS BEFORE LOADING
PER CENT DECAY
20 15 10 5 0
PER CENT DECAY
0 5 10 15 20 25 30 35
10 DAYS IN ICED CAR
1911
0.1 ON WITHDRAWAL 0.4
1.8 4 DAYS LATER 2.1
2.4 6 DAYS LATER 2.5
1913
0.6 ON WITHDRAWAL 4.0
3.0 4 DAYS LATER 10.0
5.8 6 DAYS LATER 15.6
15 DAYS IN ICED CAR
1911
0.1 ON WITHDRAWAL 1.7
1.1 4 DAYS LATER 4.9
3.6 6 DAYS LATER 4.5
1913
1.2 ON WITHDRAWAL 6.4
4.6 4 DAYS LATER 13.8
8.7 6 DAYS LATER 20.4

FIG. 6.—Diagram illustrating the percentages of decay in carefully handled nonprecooled prunes immediately loaded and those delayed two days in the warehouse before loading, Salem, Oreg., 1911 and 1913.

1911 are entirely consistent with the data given in Table V for the commercially handled prunes, the delayed lots uniformly showing more decay than those in the immediately loaded or shipped lots. It will also be noted that the figures for 1913 show considerably more decay than those for 1911, due mainly to the fact that more brown-rot developed during the season of 1913.

TABLE VI.—*Decay in carefully handled nonprecooled prunes immediately loaded and in those delayed two days in the warehouse before loading, Willamette Valley, seasons of 1911 and 1913.*

Time of inspection.	Time factors and extent of decay (per cent).							
	Season of 1911.				Season of 1913.			
	Immediate shipment.		Delayed shipment.		Immediate shipment.		Delayed shipment.	
	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.
On withdrawal	0.1	0.1	0.4	1.7	0.4	1.2	4.0	6.4
4 days after withdrawal	1.8	1.1	2.1	4.9	3.0	4.6	10.0	13.8
6 days after withdrawal	2.4	3.6	2.5	4.5	5.8	8.7	15.6	20.4

The data for 1913 emphasize even more strongly than the 1911 data the necessity for prompt shipment. After a transit period of 10 days the immediately loaded fruit showed on arrival 0.4 of 1 per cent of decay and 5.8 per cent after a holding period of six days, as compared with 4 per cent of decay on arrival and 15.6 per cent at the end of a holding period of six days in the delayed fruit. The 15-day withdrawals are equally consistent and show, of course, in the aggregate, more decay than the figures just given for the 10-day transit period. Where brown-rot is an important factor, as it was during 1913, prompt cooling and shipping is a prime necessity, and any considerable delay before cooling or shipping means the almost certain arrival of the fruit on the market in a very badly decayed condition.

EFFECT OF PRECOOLING ON CARRYING QUALITY.

The precooling experiments, as previously mentioned with cherries, were carried on in connection with a small precooling plant of 1-carload capacity built by the Salem Fruit Union under the supervision of the Bureau of Plant Industry. This plant was the first of its kind to be erected, and in it the principle of passing air directly through the mixture of ice and salt was adopted. The tank containing the refrigerating mixture is filled with crushed ice and salt, the air being passed through the bottom of the tank, and as the ice melts a new supply continually drops from the upper part of the tank. In this way the tank can be operated through an entire run without refilling. The precooling room is fitted with a false floor and return ducts, and by means of a fan the cool air is forced below the floor and through holes or openings in the false floor into the room, to circulate between the fruit packages stacked therein. The air is drawn back through the ceiling ducts to the ice tank and again circulated, the same air being used throughout the process. This method was utilized in the precooling experiments

with cherries, prunes, and loganberries, and afforded excellent facilities for testing this type of plant, the practical phases of warehouse precooling, and the relation of quick cooling to the more perishable fruits grown in this section.

Table VII and figure 7 present a comparison of the decay in the precooled and nonprecooled prunes commercially handled during the season of 1911. While these figures show consistent differences in favor of precooling, these differences are by no means as striking as are those between fruit carefully and commercially handled. The favorable results obtained from precooling are probably sufficient to justify fully the necessary expenditure in case fresh-fruit shipping becomes an established practice with prunes and other small fruits in

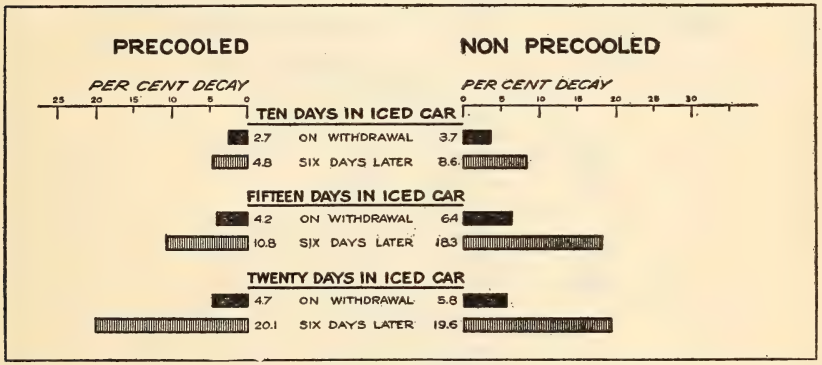
PRECOOLED
NON PRECOOLED
PER CENT DECAY
PER CENT DECAY
25 20 15 10 5 0
0 5 10 15 20 25 30
TEN DAYS IN ICED CAR
2.7 ON WITHDRAWAL 3.7
4.8 SIX DAYS LATER 8.6
FIFTEEN DAYS IN ICED CAR
4.2 ON WITHDRAWAL 6.4
10.8 SIX DAYS LATER 18.3
TWENTY DAYS IN ICED CAR
4.7 ON WITHDRAWAL 5.8
20.1 SIX DAYS LATER 19.6

FIG. 7.—Diagram illustrating the percentages of decay in precooled and nonprecooled prunes commercially handled, Salem, Oreg., 1911.

the Willamette Valley. The figures as given do not do full justice to the precooled lots, because of the rapidity with which the nonprecooled fruit cooled after being placed in the partially filled refrigerator car. The nonprecooled fruit reached a temperature of 40° F. in a very few hours, whereas under ordinary transit conditions it would have required several days for most of the fruit to be reduced to a temperature at which the ice would hold it. Therefore, in interpreting the precooling data these factors should be taken into consideration. The precooled fruit showed considerably less decay, even under the conditions under which the fruit was handled and held in this experimental work, but it is reasonable to expect that the differences would have been very much greater in favor of precooling if full car-lot shipments had been possible. In most cases the experimental lots used in these precooling experiments were placed with a full carload of fruit in the precooling room, and the work was therefore done in most cases on a commercial basis. Where the room was filled with one carload of fruit the cooling was accomplished in about six hours and required an average of about 2½ tons of ice for cooling.

TABLE VII.—*Decay in precooled and nonprecooled prunes, commercially handled, Willamette Valley, season of 1911.*

Time in iced car.	Time and treatment and extent of decay (per cent).			
	On withdrawal.		Six days after withdrawal.	
	Precooled.	Nonprecooled.	Precooled.	Nonprecooled.
10 days	2.7	3.7	4.8	8.6
15 days	4.2	6.4	10.8	18.3
20 days	4.7	5.8	20.1	19.6

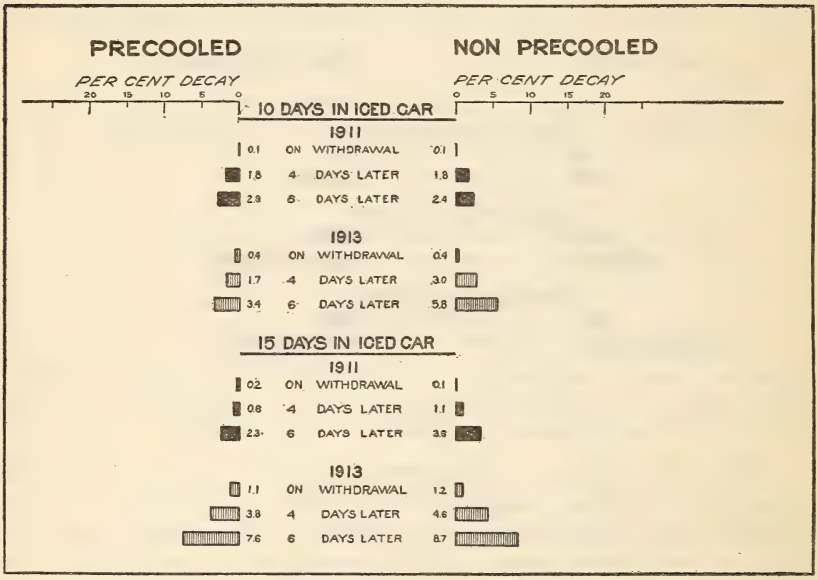

FIG. 8.—Diagram illustrating the percentages of decay in precooled and nonprecooled prunes carefully handled, Salem, Oreg., 1911 and 1913.

TABLE VIII.—*Decay in precooled and nonprecooled fresh prunes, carefully handled, Willamette Valley, seasons of 1911 and 1913.*

Time of inspection.	Time factors and extent of decay (per cent).							
	Season of 1911.				Season of 1913.			
	Precooled.		Nonprecooled.		Precooled.		Nonprecooled.	
	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.
On withdrawal	0.1	0.2	0.1	0.1	0.4	1.1	0.4	1.2
4 days after withdrawal	1.8	.6	1.8	1.1	1.7	3.8	3.0	4.6
6 days after withdrawal	2.9	2.3	2.4	3.6	3.4	7.6	5.8	8.7

Table VIII and figure 8 present the results of the precooling tests with carefully handled fruit during the seasons of 1911 and 1913.

The results in the main are consistent with those given for the commercially handled lots during the season of 1911, the differences being proportionately about the same. It will be noted that in this case also the carefully handled fruit of 1913 shows somewhat more decay than during 1911, this, as previously mentioned, being due to the greater prevalence of brown-rot during the latter season. As in the case with cherries, the precooled fruit had a fresher and brighter appearance on removal from the car.

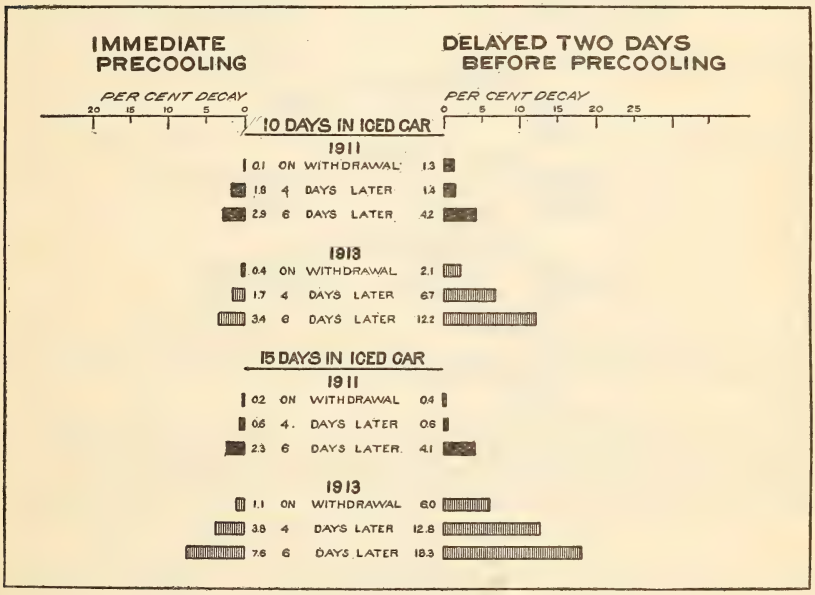

FIG. 9.—Diagram illustrating the percentages of decay in carefully handled prunes immediately precooled and those delayed two days before precooling, Salem, Oreg., 1911 and 1913.

DELAYED PRECOOLING.

To test the effect of delayed precooling as well as of delayed shipment, half of each lot or series in the precooling experiments was held two days before being placed in the precooling room. Table IX presents a comparison of the decay found in immediately cooled and in delayed fresh prunes, carefully handled, during the seasons of 1911 and 1913, and also a comparison of decay in fresh prunes similarly treated but commercially handled in the season of 1911. The results attending the carefully handled and commercially handled lots of fruit are graphically shown in figures 9 and 10, respectively.

A study of Table IX and its accompanying diagrams shows conclusively the necessity for promptness where precooling is practiced.

For instance, during 1913, in the carefully handled fruit in the 15-day withdrawal lot, the immediately precooled fruit showed 1.1 per cent of decay, as against 6 per cent in the fruit delayed prior to cooling. At the end of a 4-day holding period the fruit immediately precooled showed 3.8 per cent of decay, as against 12.8 per cent in the delayed precooled fruit. The data are equally consistent throughout and emphasize again the absolute necessity of handling the fruit from the tree to the car or the precooling plant with the utmost rapidity consistent with care in all operations.

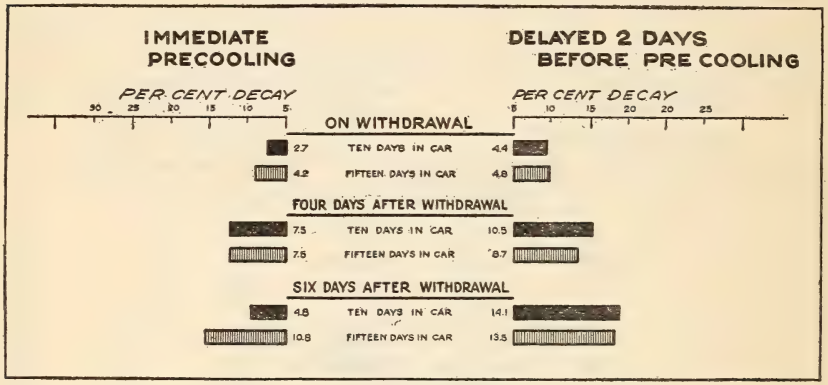
IMMEDIATE PRECOOLING
DELAYED 2 DAYS BEFORE PRE COOLING
PER CENT DECAY
30 25 20 15 10 5
PER CENT DECAY
5 10 15 20 25
ON WITHDRAWAL
2.7 TEN DAYS IN CAR 4.4
4.2 FIFTEEN DAYS IN CAR 4.8
FOUR DAYS AFTER WITHDRAWAL
7.5 TEN DAYS IN CAR 10.5
7.6 FIFTEEN DAYS IN CAR 8.7
SIX DAYS AFTER WITHDRAWAL
4.8 TEN DAYS IN CAR 14.1
10.8 FIFTEEN DAYS IN CAR 13.5

FIG. 10.—Diagram illustrating the percentages of decay in commercially handled prunes immediately precooled and those delayed two days before precooling, Salem, Oreg., 1911.

TABLE IX.—*Decay in prunes immediately precooled and in those delayed two days in the warehouse before precooling, in carefully handled and commercially handled lots, Willamette Valley, seasons of 1911 and 1913.*

Time of inspection.	Treatment, time factors, and extent of decay (per cent).											
	Carefully handled.								Commercially handled.			
	Season of 1911.				Season of 1913.				Season of 1911.			
	Immediately cooled.		Delayed 2 days before cooling.		Immediately cooled.		Delayed 2 days before cooling.		Immediately cooled.		Delayed 2 days before cooling.	
	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.
On withdrawal	0.1	0.2	1.3	0.4	0.4	1.1	2.1	6.0	2.7	4.2	4.4	4.8
4 days after withdrawal	1.8	.6	1.4	.6	1.7	3.8	6.7	12.8	7.5	7.5	10.5	8.7
6 days after withdrawal	2.9	2.3	4.2	4.1	3.4	7.6	12.2	18.3	4.8	10.8	14.1	13.5

RELATION OF BROWN-ROT TO FRESH-PRUNE SHIPMENT.

During the seasons of both 1911 and 1913, and especially during the latter season, brown-rot was an important factor in determining the condition of prunes in transit and on the market. A great deal

of the decay occurring in the earlier lots during 1913 was due to brown-rot, as was a large portion of that in the later lots. Table X and figure 11 illustrate rather strikingly the relation of brown-rot to fresh-fruit shipment.

Table X shows the total decay in the four best series in the immediately precooled and nonprecooled fresh prunes, as compared with the percentages of total decay in the four poorest series under the same methods of handling. The four series in the best lots were from orchards that were practically free from brown-rot, the four poorer series being from orchards where brown-rot was very prevalent. The fruit from the disease-free orchards at the end of a 10-day transit period showed no decay on withdrawal, 0.3 of 1 per cent at the end

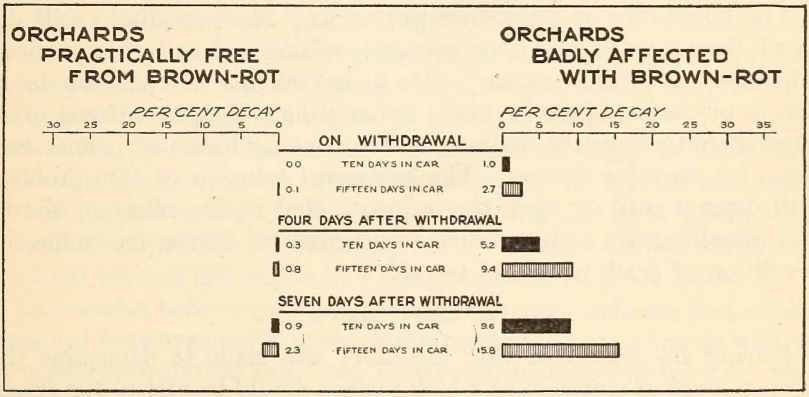
ORCHARDS PRACTICALLY FREE FROM BROWN-ROT
ORCHARDS BADLY AFFECTED WITH BROWN-ROT
PER CENT DECAY
30 25 20 15 10 5 0
PER CENT DECAY
0 5 10 15 20 25 30 35
ON WITHDRAWAL
0.0 TEN DAYS IN CAR 1.0
0.1 FIFTEEN DAYS IN CAR 2.7
FOUR DAYS AFTER WITHDRAWAL
0.3 TEN DAYS IN CAR 5.2
0.8 FIFTEEN DAYS IN CAR 9.4
SEVEN DAYS AFTER WITHDRAWAL
0.9 TEN DAYS IN CAR 9.6
2.3 FIFTEEN DAYS IN CAR 15.8

FIG. 11.—Diagram illustrating the percentages of decay in four series of prunes from orchards showing little or no brown-rot and comparable series from orchards badly affected with brown-rot, Salem, Oreg., 1913.

of 4 days, and 0.9 of 1 per cent at the end of a 7-day holding period, as against 1 per cent on withdrawal, 5.2 per cent after 4 days, and 9.6 per cent after a 7-day holding period in fruit from disease-infested orchards. It should also be kept in mind that this fruit was handled from all orchards with the greatest degree of care and that these differences were primarily due to the difference in brown-rot in the different lots. At the end of a 15-day transit period the better lots of fruit had developed only 0.1 of 1 per cent of decay on withdrawal, 0.8 of 1 per cent after a 4-day holding period, and 2.3 per cent after a 7-day holding period on the market, this as against 2.7 per cent of decay on withdrawal and 9.4 per cent and 15.8 per cent, respectively, for the poorer lots. The differences here are so striking as to indicate most clearly the need of correct cultural practices and thorough spraying in order to control the brown-rot, which during most seasons is a serious factor and one of the chief drawbacks to the successful shipment of prunes in a fresh condition.

TABLE X.—*Decay in four series of prune shipments from orchards showing little or no brown-rot and in comparable series from orchards badly affected with brown-rot, Willamette Valley, season of 1913.*

Time of inspection.	Brown-rot, time factors, and extent of decay (per cent).			
	Practically free from brown-rot.		Badly affected with brown-rot.	
	10-day withdrawal.	15-day withdrawal.	10-day withdrawal.	15-day withdrawal.
On withdrawal	0	0.1	1.0	2.7
4 days after withdrawal	.3	.8	5.2	9.4
7 days after withdrawal	.9	2.3	9.6	15.8

The possibility of marketing prunes in a fresh condition will depend, therefore, largely upon correct handling and cultural practices. The exercise of the necessary care in harvesting will prevent decay due to mechanical injuries made in handling. Proper cultural practices should secure the delivery to the packing house of prunes free from brown-rot infection. The successful solution of this problem will depend entirely upon the industry, that is, the efficiency shown in controlling the factors which to the greatest degree determine the condition of fresh prunes in transit.

MATURITY TESTS.

During the season of 1913 an effort was made to determine the proper stage of maturity at which prunes should be picked for fresh-fruit shipment. The excessive development of brown-rot in the experimental lots, especially during the early part of the season, tended to nullify any results that might have been obtained. Three picks were made one week apart, the first pick about three weeks before the fruit is normally harvested for evaporation or drying. It was believed by many people that the fruit would grow considerably between the first and last picks, but the data accumulated along this line indicate that there was no considerable increase in size between the first and third picking, except in one instance. If proper allowance is made for the prevalence of brown-rot during the early part of the season, the time of picking did not seem to have any noticeable effect on the keeping quality of the prunes. There was, however, a striking difference in the condition of the prunes at the final inspections of the early and late picks, the former showing no natural deterioration whatever, while the latter developed considerable.

The most striking fact brought out in the maturity test relates to quality. The fruit from the first pick had an excellent flavor at the end of the longest storage period for that fruit, while the fruit in the last pick, irrespective of the orchards from which it came, was almost unfit to eat, although the physical appearance was very good.

SUMMARY OF THE PRUNE INVESTIGATIONS.

Prune growing is the principal horticultural industry in the section around Salem and in other districts of the Willamette Valley, Oreg. The entire product normally is evaporated.

If a portion of the crop could be successfully shipped in a fresh state it would be of distinct advantage, at least during certain seasons, in that it would furnish an additional outlet for the profitable disposal of the crop. If prunes could be successfully and profitably shipped in a fresh state it would stabilize the industry greatly and permit its further profitable development in this and other sections well adapted to prune growing.

Numerous attempts have been made to ship prunes fresh, but with rather indifferent success. These investigations, undertaken primarily to determine the practicability of fresh-prune shipment, indicate that by the exercise of proper care in harvesting and proper orchard-sanitation practices prunes can be successfully shipped in a fresh state to markets at least as far east as Chicago.

As with cherries, success in fresh-prune shipping is dependent upon the elimination of the decay occurring in transit and after arrival on the market, this decay being due either to mechanical abrasions or injuries in handling or to brown-rot with which the fruit has become infected before being removed from the trees.

The results, both commercial and experimental, indicate that unless a radical improvement is made in the methods of handling as well as in orchard-sanitation practices, entire dependence will have to continue to be placed on evaporation for the disposal of this crop.

Prunes can be picked, hauled, and packed with comparatively little injury and resultant decay, provided the utmost care in picking is exercised to avoid bruising the fruit in placing it in the pail, in transferring it to the orchard box, and in hauling it to the packing house.

The preservation of the bloom is also a very important consideration, and this goes hand in hand with care in handling to avoid injuries.

The fruits should be grasped by the pedicel and laid one at a time in the picking pail or bucket. The common practice of holding several prunes in the hand while picking results in rubbing off the bloom and in considerable bruising and injury, as does the equally common practice of dropping the fruit into either the picking bucket or field box.

In transferring the fruit to the field box the utmost care should be taken to prevent dropping or violent rolling, both with a view to preventing injury and bruising and to preserving the bloom.

The fruit should be kept in the shade while in the orchard and hauled to the packing house on wagons provided with good springs.

The load should be protected from the sun and dust by a canvas or other cover.

In packing, the utmost care should be exercised in culling out all imperfect or cracked fruit, as the inclusion of one or a few such fruits in a crate tends to spoil the whole crate and depreciates the value of the entire shipment.

Where possible, it is desirable to pack and grade directly from the lug box, in order to prevent the injury incident to pouring the fruit out on a packing table or into a bin.

The results of the investigations bring out strikingly the necessity for prompt loading, or for prompt cooling if the fruit is precooled.

The experiments fully demonstrate the value of precooling, provided it is thoroughly done. The money and time expended in precooling are largely wasted, however, unless the fruit is properly handled in harvesting and promptly precooled.

The results of the work during the shipping seasons of 1911 and 1913 conclusively demonstrate the necessity for more careful attention to orchard-sanitation practices if fresh-fruit shipment is to become uniformly successful and profitable. During seasons of adverse climatic conditions even the utmost care in handling will not serve to deliver the fruit on the market in uniformly sound condition unless it has been protected against infection by brown-rot in the orchards.

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